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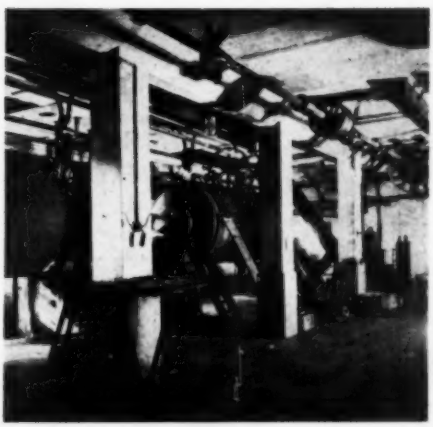

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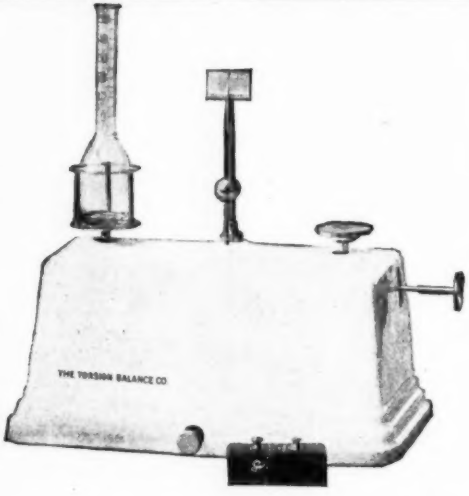

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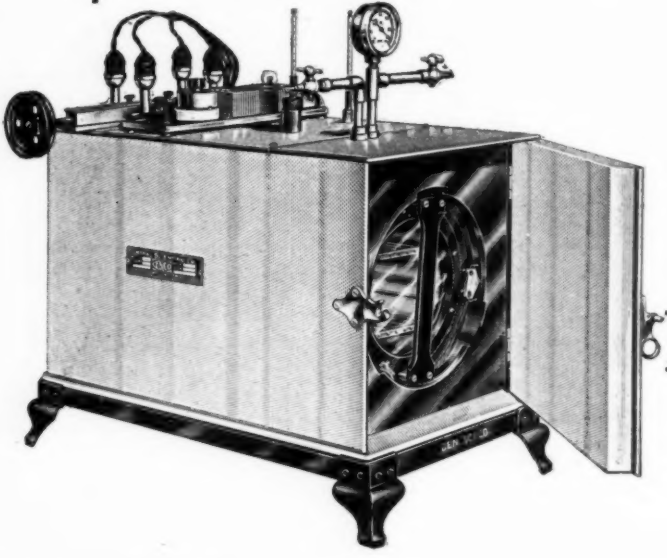


OIL & FAT INDUSTRIES

VOLUME V | JANUARY, 1928 | NUMBER 1

Ewing Galloway

Rafts of coconuts arriving at copra drying plant, Philippine Islands. Note many coconut palms in background

The Organic Oil Industry

The Romance of a Waking Giant

BY JAMES H. COLLINS

A COUPLE of years ago, word came to the Tasmanian government that penguins on Macquarie island were being marched up a sloping plank and cooked alive in steam digesters for the sake of their oil, and being so ruthlessly slaughtered that they would soon become extinct. Macquarie island is in the South Polar Seas, half way between the Antarctic continent and Tasmania, and belongs to the latter colony.

The government suspended the license of a company extracting penguin oil until it was shown that the birds were killed before going to the digesters; that the company's

employees killed from 75 to 100 seatigers every year, each with an appetite for 25 to 30 penguins a day; that the squa-gulls which eat penguin eggs were being killed; and that the penguins, far from being in danger of extermination, were numberless, being counted, not in thousands, nor hundreds of thousands, but by acres.

If you buy a cake of soap in Australia, or New Zealand, very likely it is made of penguin oil.

If you buy a cake of soap in Chicago, it may be made from animal fat by-products of the packing industry. Bought in Paris, it may be made from cocoanut oil, in London from soy bean oil, in Copenhagen from fish oil, in Barcelona from olive oil. Or it may be made of tallow, lard, cotton oil, peanut oil or palm oil in these or other places, because the soap-maker, competing with half a hundred food industries for his raw materials, must get them where he can.

The scrap of news above from the South Polar seas is typical of a great industry that has grown up almost in the present generation, and that the public knows very little about, because it doesn't begin to know itself. This is the business of finding and extracting organic oils, fats and waxes scattered over the face of the globe. It extends from the Arctic to the Antarctic, all around the seven seas, and beneath them, and in the air, with ramifications on every continent, in every civilized country, and even savage islands.

Ewing Galloway

Typical colony of penguins on an Antarctic island

Yesterday, fat was fat, just as steel was steel—suet, tallow or lard. Today, as there are hun-

dreds of varieties of steel, so there are hundreds of varieties of organic fats, drawn from vegetable, marine and even insect sources as well as animal.

The engineer, designing an automobile, specifies different kinds of hard, tough or malleable steel for various parts, according to the work they have to do. The time has come when organic oils, fats and waxes are used for specific purposes, according to their particular properties.

From the viewpoint of both production and consumption, these materials are fascinating.

They come from every clime. Up in one corner of Brazil there is a little state called Ceará, fertile and productive in normal times, but subject to terrible droughts. When the drought comes, the Cearanese used to turn to rubber—it was largely their enterprise that developed the industry on the Amazon. But rubber has now been stricken with something that promises to last longer than a Cearenese drought—the competition of the Oriental plantation product, which can be grown far below the cost of gathering wild rubber. So the Cearanese, who are called "the Yankees of Brazil," are enterprisingly developing an industry in the gathering of wild nuts that yield vegetable oils, as well as increasing their output of carnauba wax.

The animal and vegetable oils come from every clime and enter into our daily life in unsuspected

Ewing Galloway

Grove of producing olive trees over 2,000 years old, near Seville

Ewing Galloway

Prolific stand of long-staple cotton, San Joaquin Valley, California

as well as familiar ways. Popularly, they are thought of in connection with foods. The man in the street knows that his chop was fried in cooking fat which may have come from the South Sea Islands in the form of cocoanut oil, from Georgia as cotton seed oil, from the Mediterranean as olive oil, from Manchuria as peanut oil. But he does not know how these products enter into the shaving powder he uses, the shoes he wears, the box of candy he buys for his best girl.

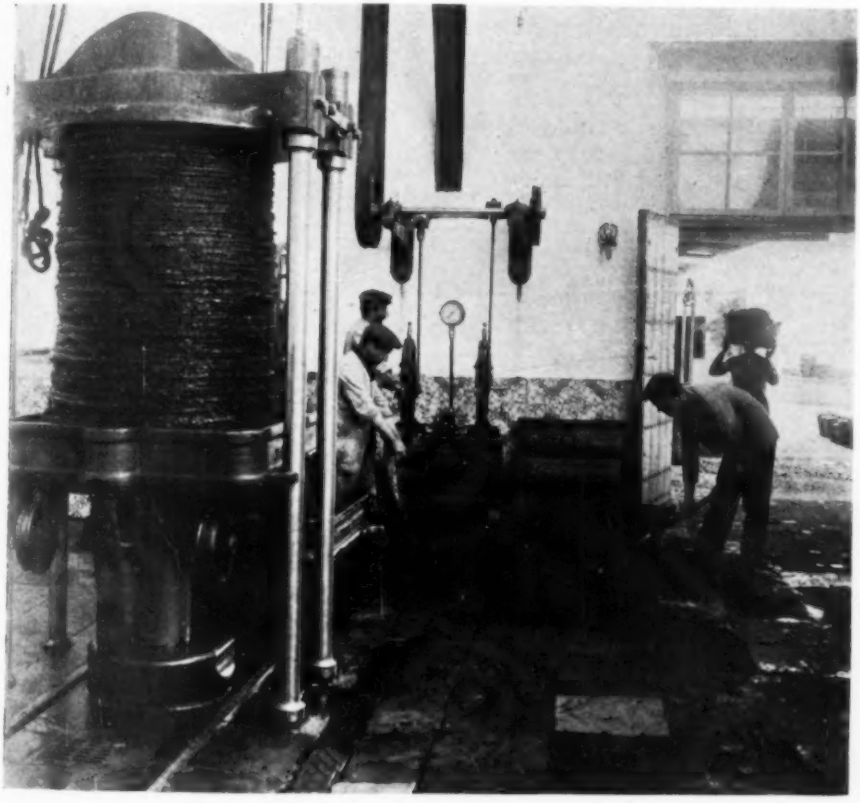
In "Creative Chemistry," Edwin E. Slosson, speaking of the vegetable oils as "solidified sunshine," gives the following uses for cottonseed products alone: Oleomargarine, cooking oil, salad oil, compound lard, setting olives, packing sardines, soap, washing powder, putty, roofing tar, linoleum, oil cloth, insulating, water-proofing paint, cotton rubber, artificial leather, fulling ware, candles, black grease, nitro-glycerine, miners' oil, substitute for sweet oil, medical emulsions, cosmetics. This is only one product of the industry, probably the best known, and it is doubtful if all the uses have been enumerated in the author's list.

As an illustration of the industry's ingenuity, Mr. Slosson tells the story of "blue bottle fly" oil, which was produced by the Germans during the war shortage of fats. They conscripted the blue

bottle fly and set it laying eggs by the billion on fish refuse. A few days sufficed to raise a crop of larvae which yielded forty-five grams per kilo of a yellow oil. It was probably used for explosives, though as Slosson points out, properly purified it would be as nutritious as any other oil—to one who had no imagination.

The world's search for new vegetable fats began as the result of a growing shortage of animal fats. This shortage is permanent. Man is using more fats and oils every year as food, and in the industries. One after another, new sources are being found and extraction put upon a successful commercial basis. There are other sources which have yet to be made profitable, and still others to be discovered. Great things have been done in production, but greater are to follow. And greater things, too, will follow in the industrial application of these products.

We are now waking up to the fact that important contributions have been made to the range of raw materials available for the manufacturer and chemist by various oils and fats. Each new addition to these products may have peculiar properties that will make it applicable in unexpected and unforeseen



Pressing ripe olives for oil, Seville, Spain

ways. Regardless of cost, it may be technically indispensable for some given purpose.

It is probably because the industry from the productive standpoint has been developed piecemeal in different parts of the world, by different groups of men, that so little has been done to make its products better known. Producers have not had the time for thorough technical research directed to finding out what is in their products, and how they may be used. The industries that consume them, as well, have lacked time for technical research in former years.

Take soap-making as a typical example. A few years ago, it was a rule-of-thumb craft, controlled by observation only, and in no way aided by the skill of the chemist or physicist. The ever-growing increase in demand for soap, and the encroachment upon the soapmaker's raw materials by other manufacturers, made it necessary to send the industry to college. The soapmaker had been throwing his glycerine away. He learned how to save it as raw material for explosives, medicines, confectionery, cosmetics and other purposes. As the solid fats were taken away from him, he learned to use the soft oils by catalytic hydrogenating processes.

Another new use of organic oils, dramatic in its effects upon a great industry, is in the separation of metals by the flotation process. It was only yesterday that mining engineers discovered that oil and an acid re-agent added to the water with which the particles of metal were separated from dross, and churned up into a bubbling frothy mixture, increased the recovery of metal from sixty to eighty and even ninety per cent. Immediately the question rose: "Which is the best oil?" and technical men have been at work on this problem ever since. The properties of different oils, giving the greatest yield from metals of different kinds, and from ores from different mines; as well as questions of cost, enter into the problem. Hundreds of different oils have been tested, and a great new market created for those that give the best results. From one-third of a pound to a pound of oil are needed to the ton of crushed ore. These oils are divided into "frothers" and "collectors." The pine oils are good frothers, while coal tar and its various derivatives are good collectors. In a general way, mining men say, oils of vegetable origin give the best results on zinc and lead ores, while mineral oils give better results on copper ores. Among the organic products used are pine oils, fir oils, wood creosotes, eucalyptus oil. In Australia, where the cost is not too great eucalyptus oil is used.

Organization is one need of the industry. Research is another. Salesmanship is needed, not only for its products, but to sell itself as an industry. In this country, thus far, united action by the different producing branches has been chiefly political, for protection against cheap-labor products from other countries. But growth must ultimately bring united action in other matters.

The Pacific Coast Oil Industry

History, Evolution and Progress of the Vegetable and Fish Oil Trades

BY P. W. TOMPKINS*

THE vegetable oil industry has a unique and picturesque history on the Pacific Coast, dating back to the early days of Spanish rule in California. We have every reason to assume that, following the arrival of the Spaniards at San Francisco in 1776, came the Spanish trading vessels, which no doubt brought the first arrivals of vegetable oils to the Pacific Coast in the form of olive oil. Until California entered the Union in 1850, the principal trading was probably with Spain, but after that date, trading vessels of other nations brought to the Pacific Coast supplies of Spanish, Italian and French olive oil, which continue to arrive today in large quantities but by modern methods of transportation.

Shortly after California was admitted to the Union, many sailing vessels of the smaller type, especially those known as "tea clippers," entered into trading between Oriental ports and San Francisco, which eventually brought to the Golden State large numbers of Chinese laborers to work in the California gold mines. The Chinese being large consumers of edible oils, it was but a short time before Chinese peanut oil appeared on the Pacific Coast. The oil at that time, and even today, for Chinese consumption here, was packed in tins of 18 lbs. net each, four tins to the case. Up to about 1890 the demand for other vegetable oils was very small. However, the Pacific Coast importers have always been most progressive in their endeavors to introduce and create outlets for various foreign vegetable oils, and through their efforts have been successful in introducing into this country oils that today occupy an important place in many American industries.

The early imports of vegetable oils were brought forward in small packages, including second-hand kerosene oil cans, wooden barrels, some shipments arriving in old wine, olive oil and beer barrels, and later puncheons and iron drums.

Many interesting changes have taken place in this industry during its long and varied development on the Pacific Coast, particularly during the spectacular World War period, when San Francisco and Seattle suddenly became the principal ports of entry for nearly the entire Oriental output. Scarcity of space owing to demand for vessels on the Atlantic side, among other reasons, forced this vast oil traffic to the Pacific Coast, whence it was distributed throughout the United States and Canada, and eventually large quantities of the finished products found their way to European countries to supply a serious need for food, and glycerine for explosives.

It is not the purpose of these remarks to deal specifically with the characteristics or properties of these oils, as this is fully covered in numerous standard works, government bulletins and scientific and trade journals. This article is intended only as a narrative of trade

* *Curtis & Tompkins, San Francisco.*

development and changes in methods of physical handling and transportation.

Methods of Shipment and Handling

Up to about 1918, very few oil importations were made in bulk, the majority arriving in the small packages referred to above. During the World War period, importations were so vast, and the industry so unprepared to properly handle such large tonnage, that great congestion and waste were inevitable; methods of handling, crude and inadequate, although later much improved.

The unpreparedness and lack of opportunity to immediately install adequate facilities to handle this immense amount of oil, made the earlier stage one of confusion. The time and labor involved in handling these millions of cases and barrels caused much concern, and showed the necessity of quickly developing machines to do part of the work. While many shipments were sent through to their destinations in their original containers, by far the greatest proportion was transfered to tank cars on the Pacific Coast. Large storage tanks had to be built, dumping tables and pumping facilities installed, but little by little equipment was developed resulting in a number of large and efficient plants. When these plants had reached a high state of efficiency, and adequate storage capacity was available, the slump of 1920-21 left them with little of their former activity. The tariff of 1922 still further reduced their sphere of usefulness, with the result that several have since gone out of existence or been modified for petroleum oil storage.

Cargoes of oil in cases at Seattle, typical of congestion and intensity of industry on the Pacific Coast during the war period

Shipments in cans and barrels were subject to heavy leakage at that time, and often many tons of

mixed oil were found in the bilges of vessels, sometimes badly emulsified with water, all of which necessitated means of salvage. In consequence, separating and filtering devices were installed to recover the oil in a salable state, which in the case of a mixture of oils, eventually found its way to the soap kettle. When the oil was not mixed but confined to a given kind, the treated and recovered product would go back to the shipment from which it originated. Frequently, however, there would be several consignees of, say, peanut oil, and disputes would naturally arise as to how much of this recovered oil belonged to the individual lots.

A serious problem arose from shipments forwarded in wooden barrels which were piled high one on the other in the vessel's hold, since the working of the staves due to the movement of the boat, together with the heavy pressure on the lower tiers, started leakage, and the oil once getting between the staves and under hoops, acted as a lubricant permitting more ready movement, which eventually loosened the staves causing leakage to become quite general. It was common to have many barrels of a lot arrive empty or only partly full. Also in the rush of war times, proper ventilation of the holds was neglected, and the expansion and contraction between the heat of the day and the cooler nights crossing the Pacific occasioned leakage in many barrels which would otherwise have withstood equal temperatures.

To overcome these difficulties, various sizings were tried out, such as silicate of soda, animal and casein glues, etc., and oil in these experimental barrels was sent over and back from the Orient to test their comparative merits. Hoops were also "dogged" in place so they could not shift, and as a result of

Three conveyor chutes in background moving empty cases to fire dump

these betterments, it was eventually found possible to ship in wooden barrels with only small occasional leakage, and these methods are usually followed at the present time when barrel shipments are made.

Cocoanut oil shipments in these numerous small packages naturally presented a difficulty not affecting other oils, since it is solid at normal temperatures and there had to be some means of melting prior to transferring it to tank cars or storage tanks. This was accomplished by erecting crude wooden rooms in which steam coils were placed, the barrels and tins being heated in these rooms. Sometimes the barrels, drums and cans were laid over inflexible steam coils and covered with canvas, until the oil had melted. Frequently these same contrivances would be augmented by allowing live steam to escape at various places around the cans. A favorite method was to shoot live steam into barrels until they were empty, allow the mixture of oil and condensed water to settle in some receptacle and then draw off the

Sampling barreled and case goods under these conditions presented difficulties

Rows of piles of cases such as this sometimes had to be pulled down several times for sampling purposes

water. Needless to say, plenty of water was left in the oil at times, though it was remarkable how well it could be removed when time and opportunity permitted. Later this was all handled by machines created for the purpose, cans were moved along by conveyors surrounded by steam coils until they reached the dumping and draining tables and from there the empty cans went to the cutting, flattening and baling machines.

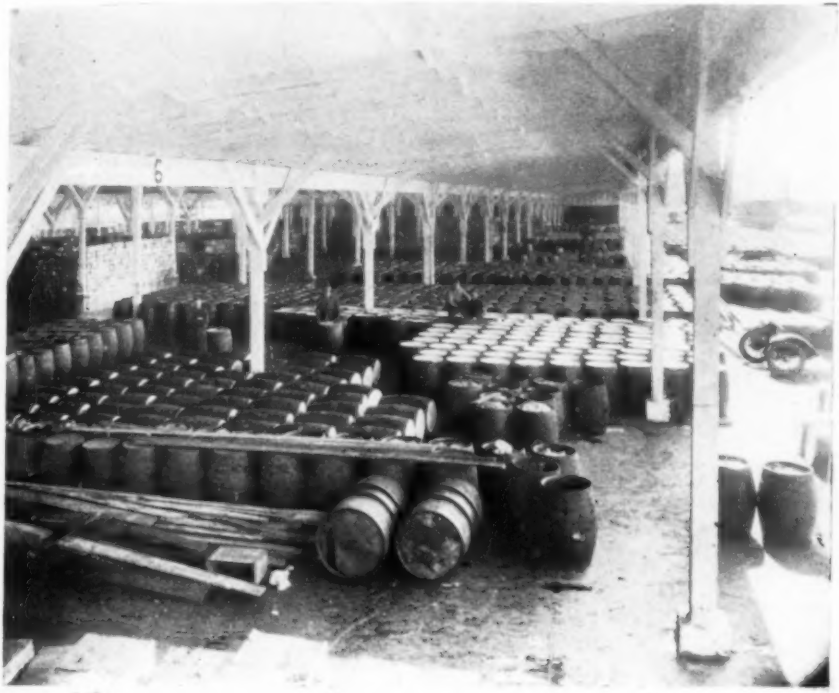
With such a demand for oil as existed during the war period, and the confusion that prevailed, a marked irregularity between lots and even packages of the same lot

was inevitable. While lots, as a whole, might comply with contract limitations or standards, when subdivided on arrival here and sent to different buyers, the part that each received would frequently be quite different from the average of the whole. Sometimes a sample of 10% of the packages would be taken of a shipment on arrival, and during the numerous subsequent sales and resales characteristic of the time, portions would be sampled again or several times. Each sample drawn would involve packages not previously sampled, and each sampling would vary from the first or second, and so on down the line of sales and resales, and the chemist, not the irregularity of the product, was always blamed for these differences. As many as five and six samplings might be made of a lot representing as many independent transactions without the shipment moving from the spot where it was discharged from the vessel. In the oil terminals or warehouses, barrels and cases would be piled ceiling high, and frequently had to be pulled down several times to be resampled as a result of a new buyer in the case. Some of these vegetable oils, especially cocoanut, would vary so much that every individual barrel in a shipment would have to be sampled, tested for free fatty acids and segregated into the

One of the fine oil transfer plants which was an outgrowth of wartime conditions. In the foreground, bales of flattened coal oil tins ready for return to the Orient. Middle and outer wharf, barrels of bean oil

range to which it belonged, before the importer could take the risk of selling his product. Portable laboratory equipment would on such occasions be used on the dock where the sampling and segregation took place. Such extreme irregularity, of course, did not occur frequently, but was not uncommon.

This condition naturally had its effect on tank car lots loaded directly from packages, as the last oil into the tank car would always predominate in the sample taken from the dome of the car, and consequently did not necessarily represent the average of the tank car as a whole. Tank cars were also usually sampled and tested at destination, and as a result of these conditions, discrepancies were inevitable, and after continued disputes had arisen, the importers found it necessary for their protection to evolve a different system in order to know with certainty the average composition of the car before shipment. It was not an uncommon sight in the earlier days of this mad rush, to see two men at the dome of the car, trying to mix the oil with oars.



Background, thousands of cases of peanut and other oils. This scene is typical of order and system resulting from improved methods towards end of war period

Out of all this confusion grew the various sampling and other devices to overcome these difficulties. Dumping tables were established in which the oil passed into long troughs, much like those in

Wreckage after discharge of vegetable oil cargo at San Francisco in 1920, resulting in 4 feet of oil leakage in bilge of this hold.

Another view of same vessel as photograph above, showing result of poor stowage and rough weather

which cattle are fed. Some of these were arranged with mixing propellors and others with circulating devices where the oil would be pumped over from one end to the other, and by this means mixed sufficiently to be of a uniform composition. Numerous modifications or combinations of these procedures were installed, with the eventual development of immense storage capacity where the oils would finally be pumped from the dumping tables. In that way conditions were averaged and oil of a uniform and known composition resulted.

It would be impossible for anyone who has not witnessed the congestion caused by these vast oil importations, when entire ships' cargoes of mixed lots or a single kind of oil would arrive at one time and smaller shipments of 50,000 to over 100,000 cases were of almost daily occurrence, to visualize the many difficulties which confronted nearly every turn of these transactions, and as usual the chemists and their samplers came in for the brunt of all blame when anything did not come out just as was expected. But out of all the grief and difficulties in meeting contracts and conditions, much good was derived. It not only gave a great impetus to the oil industry, but developed knowledge of handling and the many uses and applications of various oils. Had it not been for the period of the war, development of this sort would have been much slower and there would not have been so many well equipped plants as exist to day, with first hand knowledge and experience of a valuable order. Pacific Coast ports, such as San Francisco, Seattle, Tacoma, Portland and Los Angeles, now have oil storage plants for handling the various oils shipped in bulk, which represent an enormous investment of money, but are most essential to the vegetable oil industry.

One form of equipment which has been junked as useless under modern conditions, is the machinery created for cutting, flattening (rolling), and baling the millions of second-hand coal-oil tins which were then returned to the Orient to be used for roofing of houses and all sorts of purposes by the Orientals, or sometimes made into smaller cans which were again returned with oil. The problem of disposing of the wooden cases, each of which held two of these cans, was met in much the same way as the problem of waste wood and sawdust in sawmills. Conveyors were installed which carried these cases to some remote point where they were dumped and burned. These fires were going day and night, and millions of oil-soaked cases were destroyed in this way. Present methods of transportation and handling have been so simplified that one or two thousand tons of bulk oil in steamers' deep tanks can be transferred directly into tank cars or storage tanks within a period of from 12 to 24 hours with very little more labor than is necessary to man and connect the pumps and attend the tank cars. It is much more economical and satisfactory in every way than the former laborious, wasteful and costly procedure, which was only economically possible as a result of market demand of a kind created by war conditions.

In the next issue, a brief sketch will follow of various oils imported on the Pacific Coast. It is not intended to cover the entire field but merely the better known oils, including fish and marine oils.

(To be continued)

Color Glass Standardization*

A Study of 129 Lovibond Red Glasses with Respect to the Reliability of Their Nominal Grades**

BY DEANE B. JUDD† AND GERALDINE K. WALKER††

I. Introduction

PREVIOUS experience and investigations have shown that the grading of red Lovibond glasses[1] between 7.0 and 8.0, as supplied by the proprietors of the system, is inconsistent by several tenths of a unit. That is to say, glasses marked with numerals differing by several tenths of a unit may be alike in color; and, vice versa, glasses marked with the same numeral may differ in color by an amount corresponding to several tenths of a unit[2].

The purposes of the examination and sorting to be described are:

(1) To investigate these irregularities at 7.0 to 8.0 on the red scale somewhat more extensively and carefully than has been done heretofore, and

(2) To select from a large group of glasses of nominal values between 7.0 and 8.0 the ones which should truly be graded as 7.6 ± 0.1.

II. The Glasses

The glasses with which we are concerned in the present report were collected and submitted by the American Oil Chemists' Society[3]. It is understood that nearly all of them are glasses which have been in use in the grading of vegetable oils by members of that Society. When submitted, the glasses had already been labeled with numbers which will be used to identify them in the present report[4].

III. Methods of Examination and Sorting

The original intent of the present examination was merely to sort these glasses into the following groups:

(1) Those which are so nearly the standard 7.6 as not to be distinguished from it by the most careful direct comparison of color.

(2) Those which are probably greater than 7.6 but certainly not greater than 7.7,

(3) Those which are probably less than 7.6 but certainly not less than 7.5,

---

*Publication approved by the Director of the Bureau of Standards, U. S. Dept. of Commerce. This report was presented (orally by Priest) at the meeting of the A. O. C. S., New York, October 28, 1927.

†*Associate Physicist, Bureau of Standards.*

††*Research Associate, American Oil Chemists' Society.*

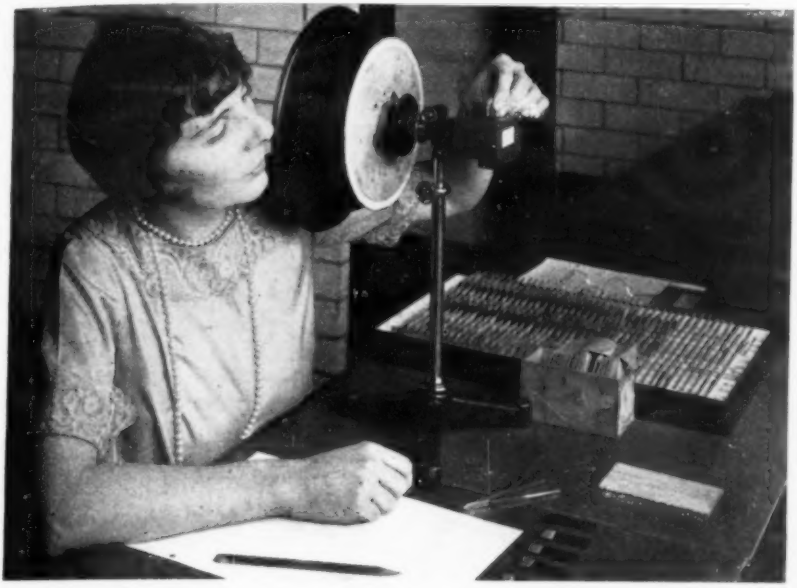
**This work was carried out under the direction of Mr. Irwin G. Priest who also outlined the form which this report has taken. The authors acknowledge their indebtedness to him and also to Mr. J. O. Riley who acted as an observer.

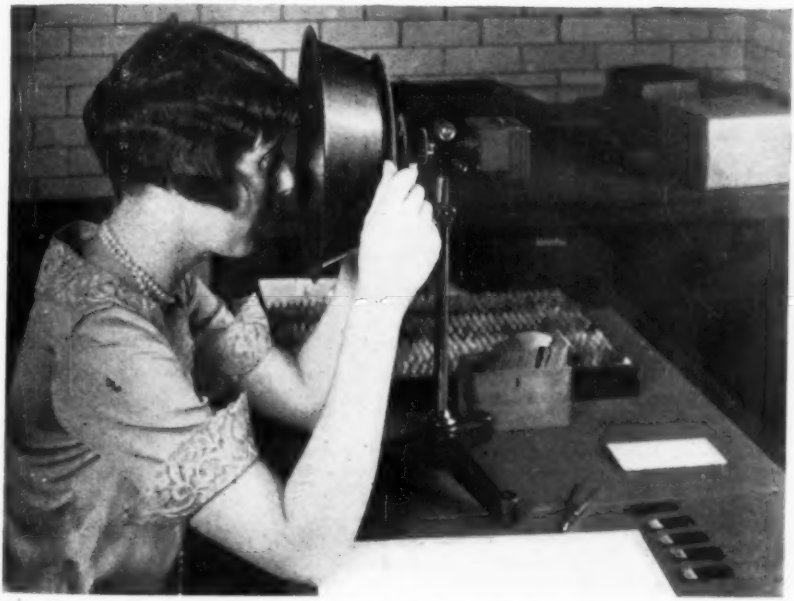
[1]Tintometer, Ltd., Salisbury, Eng., Descriptive Circular and Price List. J. W. Lovibond, Measurement of Light and Colour Sensations, George Gill and Sons, London, Chapter II. The Lovibond Color System—A Spectrophotometric Analysis of the Lovibond Glasses; K. S. Gibson and F. K. Harris, B. S. Sci. Paper 547, (Government Printing Office, Washington, February 17, 1927).

[2]B. S. Sci. Pap. 547, p. 9.

[3]Submitted to the Bureau of Standards by Harry P. Trevithick, President, A. O. C. S., No. 2 Broadway, New York, N. Y., as follows: Identification numbers (See table 1, first column) 1 to 187, August 4, 1927; Identification numbers 188 to 190, August 27, 1927; Identification numbers 192-195, September 24, 1927.

[4]It is understood that Mr. Trevithick has a key to the numbers showing the ownership of the glasses.





Miss Geraldine K. Walker, Research Associate of the American Oil Chemists' Society, comparing Lovibond Glasses by means of the Martens Photometer at the Bureau of Standards

Upper: Placing glass in the comparator

Lower: Adjusting brightness match and comparing hues of two glasses

(4) Those which are greater than 7.7[5], and

(5) Those which are less than 7.5[6].

As the work progressed it appeared desirable to extend it to include the actual regrading of each of the glasses to an accuracy of about 0.1 or 0.2; and, in the end, this has also been done. To imitate as closely as possible the condition under which the calibration is of most critical interest, the classification has been made with the glasses in combination with 35-yellow.

Their classification has been based solely on hue and saturation in a direct comparison of the color of the submitted glasses with the color of the standards. Brilliance has been varied and equated in judging the equality of hue and saturation; possible differences in brilliance have not, however, been regarded in this classification[7].

The color comparisons have been made by means of a Martens photometer[8], used essentially as follows:

(1) A piece of milk glass standing in a vertical plane between a north window and the photometer is illuminated by the light from the sky.

(2) The photometer, with its axis horizontal, is placed so that its photometric field is evenly illuminated by light transmitted by the milk glass.

(3) The glasses to be compared are held in a black chamber between the milk glass and the photometer so that one half of the photometric field is illuminated by light transmitted through the standard glass, or standard combination of glasses[9], and the other half by light transmitted through the glass under test. In all cases the effective portion of each glass is symmetrical about the geometrical center of that glass.

(4) The exit pupil of the photometer is covered by a 35Y glass through which the observer looks in comparing the standard glass and the glass being tested.

(5) The observer can match the brilliance of the two halves of the field by adjustment of the photometer itself.

(6) The positions of the standard and test glasses are reversed before final judgment is made.

The initial procedure was to sort the glasses into groups. First, each glass was compared with the standard 7.6 and placed as a result of this comparison into one of three groups: (1) less than 7.6, (2) indistinguishable from 7.6, and (3) greater than 7.6. Then the sorting was carried out with reference to a combination of two glasses the first glass being the standard 7.6; the second, a Lovibond red glass whose value is known to be very close to 0.1 Lovibond red unit. This combination may be thought of as a standard 7.7. Then, each submitted glass in combination with the 0.1 glass was compared to the standard 7.6. It is apparent that this procedure is

[5]In this class, glasses which are so near 7.7 as to make their classification doubtful are indicated by a question mark (?) in Table 1.

[6]In this class, glasses which are so near 7.5 as to make their classification doubtful are indicated by a question mark (?) in Table 1.

[7]For significance of these terms, see: "Report of Colorimetry Committee," Optical Society of America, J.O.S.A. & R.S.I., 6, pp. 534-535, (August, 1922). (Separate copies of this report may be purchased at 50 cents each of Professor F. K. Richtmyer, Bus. Mgr., J.O.S.A. & R.S.I., Cornell University, Ithaca, N. Y.)

[8]As exhibited to the American Oil Chemists' Society and used in testing the color discrimination of members at Memphis, Tenn., May, 1927.

For original technical description of the instrument, see: Phys. Zeitschrift, 1, pp. 299-303 (1900).

[9]When the standard was a combination of two or more glasses, clear glasses were added so that the light illuminating one half the field passed through as many reflecting surfaces as that illuminating the other half.

equivalent to the comparison of each submitted glass with a standard 7.5 Lovibond red glass, the standard 7.5 being produced by negative combination with the standard 7.6. In effect, then, each submitted glass was compared to three standards, the standard 7.6, the standard 7.7, and the standard 7.5. The glasses were independently sorted against these three standards by three observers (DBJ, IGP, JOR).

The actual regrading (by GKW verified in part by DBJ) of the submitted glasses was accomplished by sorting the glasses in the same way against a large number (instead of just three) of standard combinations so chosen that each glass submitted was a close color match for one of them. The additional standard combinations were obtained by adding, either positively or negatively, other Lovibond red glasses of small known denomination to the standard 7.6. The grade of the standard combination (Table 1, third column) which was found to match a given submitted glass was taken as the regrade numeral (on the scale of Priest and Gibson, Cf. Section IV,) for that glass.

The results from the four observers have been compared; and doubtful or contradictory findings have been verified or corrected. The final findings of the four observers have been interpreted in the following way in order to place the glasses in the groups indicated above:

(1) A glass belongs to group 1 (indistinguishable from 7.6) provided all observers on every trial failed to distinguish it from 7.6.

(2) A glass belongs to group 2 (probably greater than 7.6 but certainly not greater than 7.7) provided, first, that one observer judged it greater than 7.6, and, second, provided also that no observer judged it greater than 7.7.

(3) A glass belongs to group 3 (probably less than 7.6 but certainly not less than 7.5) provided, first, that one observer judged it less than 7.6, and, second, provided also that no observer judged it less than 7.5.

(4) A glass belongs to group 4 (greater than 7.7) provided one observer judged it greater than 7.7.

(5) A glass belongs to group 5 (less than 7.5) provided one observer judged it less than 7.5.

IV. Standards and Accuracy

The standards are those recently established by Priest and Gibson at the Bureau of Standards[10]. The particular 7.6 glass used as standard is identified by the mark "B.S.9940"[11]. It was obtained directly from the Tintometer, Ltd., Salisbury, England, and delivered to the Bureau, December 11, 1912[12]. It was graded 7.6 by the Lovibond establishment. Its computed value is 7.59 on the scale established by Priest and Gibson from the set of glasses identified by the mark "B.S.9940." This computation is uncertain by 0.01 or 0.02 but these small differences

[10] Complete description of this standardization has not yet been published. A brief description was given orally by Priest at the Convention of the A. O. C. S., Memphis, May, 1927, and at the Twelfth Annual Meeting of the Optical Society of America, Schenectady, N. Y., October, 1927 (For abstract see J. O. S. A. & R. S. I., 16, 1928). It is expected that a complete account of this standardization will be published later as a B. S. Sci. Paper.

[11] This is the Bureau of Standards inventory number for the complete set of glasses containing the 7.6 used as standard. The glasses of this complete set have, in a sense (See Gibson and Harris, loc. cit. p. 6) been adopted as standard by agreement with the Society of Cotton Products Analysts (now American Oil Chemists' Society).

[12] On B. S. Order No. 13644.

Table 1. - Complete Summary

Identification Number as submitted	Lovibond Numeral engraved on glass (Letters refer to notes, see last column)	Approximate Lovibond Numeral found by one observer (GKW)	Lovibond Numeral as graded in this examination	Notes
161	6.0 a	6.758	less than 7.5	a This glass was submitted by mistake since the group was expected to consist of glasses of nominal grade between 7.0 and 8.0. The engraved marks are: "Lovibond, Colour Scale, 200 NT, 6.0,". (The commas within the quotation marks, in this note and in those which follow, indicate the end of a line of engraving. They are not a part of the engraved marks.)
11	7.0 b	6.98	less than 7.5	
38	7.0 c	6.98	less than 7.5	
64	7.0 d	6.75	less than 7.5	
65	7.0 d	7.16	less than 7.5	
73	7.0 e	7.21	less than 7.5	
93	7.0 f	6.96	less than 7.5	
120	7.0 g	6.98	less than 7.5	
121	7.0 f	7.07	less than 7.5	b The engraved marks, aside from the numeral, are: "Lovibond's, Colour Scale, 200 NT, R,".
128	7.0 h	7.308	less than 7.5	
132	7.0 h	7.18	less than 7.5	c The engraved marks, aside from the numeral, are: "Lovibond's Colour Scale, 200 NT, H ,".
133	7.0 i	7.27	less than 7.5 (?)	
142	7.0 f	7.498	less than 7.5 (?)	
143	7.0 j	7.338	less than 7.5	d The engraved marks, aside from the numeral, are: "Lovibond, Colour Scale, 200 NT,".
159	7.0 k	7.63	less than 7.5	
163	7.0 k	7.34	less than 7.5 (?)	e The engraved marks are: "Lovibond's, Colour Scale, 200 NT, 7.0 R,". A paper label on this glass was marked "7.5".
167	7.0 l	7.42	less than 7.5	
184	7.0 cc	7.34	less than 7.5	
185	7.0 d	7.74	greater than 7.7 (?)	
3	7.1 j	7.27	less than 7.5	f The engraved marks, aside from the numeral, are: "200 NT",.
21	7.1 j	7.07	less than 7.5	
24	7.1 j	7.08	less than 7.5	g The engraved marks, aside from the numeral, are: "Lovibond's, Colour Scale, 200 NT, F ,".
25	7.1 j	7.07	less than 7.5	
28	7.1 f	7.91	greater than 7.7	
34	7.1 j	6.89	less than 7.5	h The engraved marks, aside from the numeral, are: "Lovibond, Colour Scale, 200 NT, H,".
35	7.1 f	7.14	less than 7.5	
45	7.1 j	7.01	less than 7.5	i The engraved marks are: "Lovibond's, Colour Scale, 200 NT, 7.0 W,". A vertical line is scratched through the digit "0" of the "7.0". On the reverse side of the glass a "7.1" is deeply etched. A paper label on this glass was marked "7.1".
47	7.1 j	6.91	less than 7.5	
72	7.1 f	7.18	less than 7.5	
99	7.1 f	7.338	less than 7.5	
83	7.1 g	7.31	less than 7.5	
86	7.1 j	7.14	less than 7.5	
94	7.1 f	7.08	less than 7.5	j The engraved marks, aside from the numeral, are: "Lovibond's, Colour Scale, 200 NT,".
112	7.1 j	7.448	less than 7.5 (?)	
117	7.1 j	6.89	less than 7.5	
122	7.1 f	7.34	less than 7.5 (?)	k The engraved marks are: "Lovibond, Colour Scale, 200 NT, 7.0 H, England,".
123	7.1 f	7.498	between 7.5 and 7.6	
126	7.1 f	7.07	less than 7.5	l The engraved marks, aside from the numeral, are: "Reg'd. No., 410631, 200 NT, W,".
138	7.1 f	7.31	less than 7.5 (?)	
154	7.1 j	7.27	less than 7.5	
166	7.1 f	7.01	less than 7.5	m A part of this glass is chipped off. The engraved marks might correspond either to note (d) or to note (j).
169	7.1 m	7.07	less than 7.5	
170	7.1 j	6.70	less than 7.5	
182	7.1 n	8.11	greater than 7.7	n Engraved as in note (f). The numeral is 7.1, the digit "1" of the "7.1" being somewhat indistinct. A paper label on the glass was marked: "7.9 LJ,".
4	7.4 o	7.87	greater than 7.7	
52	7.4 p	7.668	between 7.6 and 7.7	
171	7.4 h	7.338	less than 7.5	
172	7.4 q	7.34	less than 7.5 (?)	o The engraved marks are: "NT, 200, R 7.4, 7.25,". Through the "7.25" two horizontal lines have been scratched.
2	7.6 c	7.44	less than 7.5 (?)	
6	7.6 q	7.528	between 7.5 and 7.6	
7	7.6 r	7.448	less than 7.5 (?)	p The engraved marks, aside from the numeral, are: "200 NT, L ,". The "L" is indistinct.
10	7.6 s	7.87	greater than 7.7	
17	7.6 t	7.91	greater than 7.7	
18	7.6 u	7.69	between 7.6 and 7.7	q The engraved marks, aside from the numeral, are: "Lovibond's, Colour Scale, 200 NT, g,".
19	7.6 b	7.728	greater than 7.7 (?)	
20	7.6 j	7.59	7.6	r Engraved as in note (1) except that a "g" appears instead of the "W".
33	7.6 v	7.42	less than 7.5 (?)	
36	7.6 w	7.84	greater than 7.7	
39	7.6 ss	7.31	less than 7.5 (?)	s Engraved as in note (1) except that the "W" did not appear.
44	7.6 q	7.76	greater than 7.7 (?)	

are quite inappreciable in a direct comparison of color.[13]

The Bureau of Chemistry, N. Y. Produce Exchange, has a 7.6 Lovibond red glass which is an exact duplicate of this standard in so far as hue and saturation are concerned. The present standard agrees to within less than 0.1 R with the standard used by Priest and Wesson in calibrating sixteen glasses in October 1920[14].

[13]For the sake of brevity, then, we say simply the "standard 7.6" although the computation

Table 1 (continued)

45	7.6 ff	7.31	less than 7.5 (?)	t The engraved marks are: "Lovibond, Colour
53	7.6 k	7.84	greater than 7.7	Scale, 200 NT, L 7.6,".
54	7.6 r	7.57	less than 7.5	
58	7.6 q	7.59	7.6	u The engraved marks, aside from the numeral,
59	7.6 u	7.298	less than 7.5	are: "Lovibond, Colour Scale, 200 NT, M,".
67	7.6 y	7.67	greater than 7.7	v Engraved as in note (1) except that an "F"
81	7.6 j	7.643	between 7.6 and 7.7	appears instead of the "E".
82	7.6 b	7.76	greater than 7.7	
87	7.6 z	8.10	greater than 7.7	w The engraved marks are: "200 NT, N 7.6,".
88	7.6 d	7.59	between 7.5 and 7.6	
92	7.6 j	8.11	greater than 7.7	x The engraved marks are: "200 NT, g 7.6,".
95	7.6 l	7.91	greater than 7.7	y The engraved marks, aside from the numeral,
104	7.6 b	7.34	less than 7.5 (?)	are: "Lovibond, Colour Scale, 200 NT, W,".
105	7.6 b	7.34	less than 7.5 (?)	
106	7.6 v	7.59	7.6	z The engraved marks are: "200 NT, 7.6, F,".
107	7.6 q	7.76	greater than 7.7	bb The engraved marks, aside from the numeral,
109	7.6 bb	7.59@	7.6	are: "Lovibond's, Colour Scale, 200 NT, L
111	7.6 d	7.91	greater than 7.7	
118	7.6 bb	7.338	less than 7.5	cc The engraved marks, aside from the numeral,
124	7.6 v	7.438	less than 7.5 (?)	are: "Lovibond, Colour Scale, 200 NT, R,".
144	7.6 p	7.69	between 7.6 and 7.7	dd The engraved marks are: "Lovibond, Colour
147	7.6 y	7.74	greater than 7.7 (?)	Scale, 200 NT, 7.6 R,". A part of this glass
149	7.6 dd	7.74	greater than 7.7	has been chipped off so that the first line
158A	7.6 ee	7.648	between 7.6 and 7.7	of engraving might have read "Lovibond's".
185	7.6 j	7.466	less than 7.5 (?)	
				ee The engraved marks are: "Lovibond, Colour
160	7.6 b	8.00	greater than 7.7	Scale, 200 NT, F 7.6, England,".
173	7.6 q	7.69	between 7.6 and 7.7	
174	7.6 g	8.39	greater than 7.7	ff The engraved marks are: "Lovibond's, Colour
175	7.6 ff	7.595	between 7.5 and 7.6	Scale, 200 NT, N 7.6,".
176	7.6 g	8.43	greater than 7.7	
177	7.6 l	7.728	greater than 7.7 (?)	gg The engraved marks are: "Lovibond's, Colour
178	7.6 q	7.74	greater than 7.7	Scale, 200 NT, E 7.6,". In the last line of
179	7.6 l	7.84	greater than 7.7	engraving the "E" is indistinct.
188	7.6 d	7.69	between 7.6 and 7.7	
189	7.6 d	7.59	between 7.5 and 7.6	hh The engraved marks correspond to note (bb).
				There is also an "R" through which two lines
190	7.6 d	7.758	greater than 7.7 (?)	have been scratched.
192	7.6 d	7.648	between 7.6 and 7.7	
193	7.6 u	7.744	greater than 7.7 (?)	ii The engraved marks are: "200 NT, g 7.6,".
194	7.6 d	7.758	greater than 7.7 (?)	
195	7.6 l	7.749	greater than 7.7 (?)	jj Engraved as in note (ii). A paper label on
				the glass was marked: "7.5 Cudahy".
28	7.8 gg	7.84	greater than 7.7	
29	7.8 hh	7.87	greater than 7.7	kk The engraved marks are: "Lovibond's, Colour
56	7.8 ii	8.11	greater than 7.7	Scale, 200 NT, p 8.0,". A paper label on the
66	7.8 q	7.698	between 7.6 and 7.7	glass was marked "7.8".
69	7.8 g	8.33	greater than 7.7	
				ll The engraved marks are: "200 NT, 8.0 E,". The
70	7.8 e	7.84	greater than 7.7	"E" is in upper case script and is indistinct.
80	7.8 jj	8.20	greater than 7.7	
89	7.8 b	8.30	greater than 7.7	mm The engraved marks are: "Lovibond, Colour
90	7.8 j	7.754	greater than 7.7 (?)	Scale, 200 NT, F 8.0,".
113	7.8 q	8.39	greater than 7.7	
				nn The engraved marks are: "Reg'd No, 410631,
139	7.8 q	7.748	greater than 7.7 (?)	200 NT, L 8.0, England,". There is also a
1	8.0 d	8.11	greater than 7.7	small engraved symbol roughly resembling a
9	8.0 j	8.30	greater than 7.7	crown. See note (b).
40	8.0 kk	7.87	greater than 7.7 (?)	
60	8.0 g	8.15	greater than 7.7	oo Engraved as in note (nn) except that the "L"
				is omitted.
66	8.0 d	8.17	greater than 7.7	
74	8.0 j	8.20	greater than 7.7	pp Engraved as in note (j). A paper label on the
98	8.0 ll	8.15	greater than 7.7	glass was marked "8.1 LJ".
134	8.0 mm	8.11	greater than 7.7	
136	8.0 nn	8.32	greater than 7.7	qq Submitted by mistake; see note (a). The engraved
				marks are: "200 NT, F 8.2, Lovibond's, Colour
145	8.0 e	8.02	greater than 7.7	Scale,". Two vertical lines have been scratched
161	8.0 j	8.50	greater than 7.7	through the digit "2" of the "8.2".
184	8.0 oo	8.33	greater than 7.7	
180	8.0 b	8.30	greater than 7.7	rr Submitted by mistake; see note (a). The engraved
183	8.0 pp	8.11	greater than 7.7	marks are: "200 NT, g 8.9,". A paper label
				on this glass was marked "8.0".
186	8.0 h	8.11	greater than 7.7	
187	8.0 y	8.52	greater than 7.7	ss The engraved marks are: "Lovibond's, Colour
189	8.2 qq	8.17	greater than 7.7	Scale, 200 NT, F 7.6,". A paper label on the
30	8.9 rr	9.03	greater than 7.7	glass was marked "7.1".

@ The average of three determinations

gives 7.59. Likewise we say the "standard 7.5" and the "standard 7.7" although the computation yields 7.49 and 7.69 respectively. This designation is used in the tables which follow wherever division into the groups (1) to (5) is meant. In the third column of Table 1, however, in which is given the regrade numerals found by one observer (GKW), the values of the corresponding standards are given as computed to 0.01 Lovibond red units. We do this because we wish to give the most probable regrade numeral for each glass; but this should not be taken to imply that the observations by GKW or even the standards are accurate to 0.01 Lovibond red units.

[14] "Report on Calibration of Sixteen Lovibond Red Glasses of Nominal Value 7.6," Cotton Oil Press, January, 1921. (Separate copies of this report may be had on application to Irwin G. Priest, Bureau of Standards, Washington, D. C.)

V. Results

The essential results are summarized in the tables (1, 2, 3, 4) and graph (Fig. 1)

VI. Discussion of Results

The experimental uncertainty of the results presented in Table 1 is such that we can certify the division into groups only to 0.05 Lovibond red units. The regrade numerals presented in the third column of Table 1 represent (except as noted) a single determination by one observer (GKW); they have been checked (by DBJ) for gross mistakes such as would result from purely clerical errors; hence, we can certify them to be within 0.20 Lovibond red units of the true numeral. We believe a great majority of them are within 0.10 units of the true numeral. Certain of these glasses have been independently graded twice by one observer (GKW) and at least once by another observer (DBJ); the regrade numerals (indicated by the symbol @, in the third column of Table 1) resulting from an average of these three or more determinations may, we believe, be regarded correct to 0.10 Lovibond red units.

TABLE 2

List of Glasses Accurately 7.6

20	106
58	108

TABLE 3

List of Glasses Not Less Than 7.5 Nor Greater Than 7.7
(Including those in Table 2)

6	52	81	108	152A	188
18	58	88	123	173	189
20	68	106	144	175	192

The information in Tables 2, 3, and 4 may be found from a study of Table 1 (fourth column). This information is assembled in tabular form to render it more readily accessible. Likewise has the distribution of glasses of constant nominal value according to regrade value (shown graphically, Fig. 1) been evaluated from the results presented in Table 1 (third column).

TABLE 4

Analysis of Group Regraded Between 7.5 and 7.7 With Respect to Their Grades as Submitted

Engraved Numeral	Number of Glasses Submitted	Number of Glasses Included in Regrade Group 7.5 to 7.7
6.0	1	0
7.0	18	0
7.1	25	1
7.4	4	1
7.6	52	15
7.8	11	1
8.0	16	0
8.2	1	0
8.9	1	0
Total	129	18

It will be observed from Table 4 that, of the 18 glasses graded be-

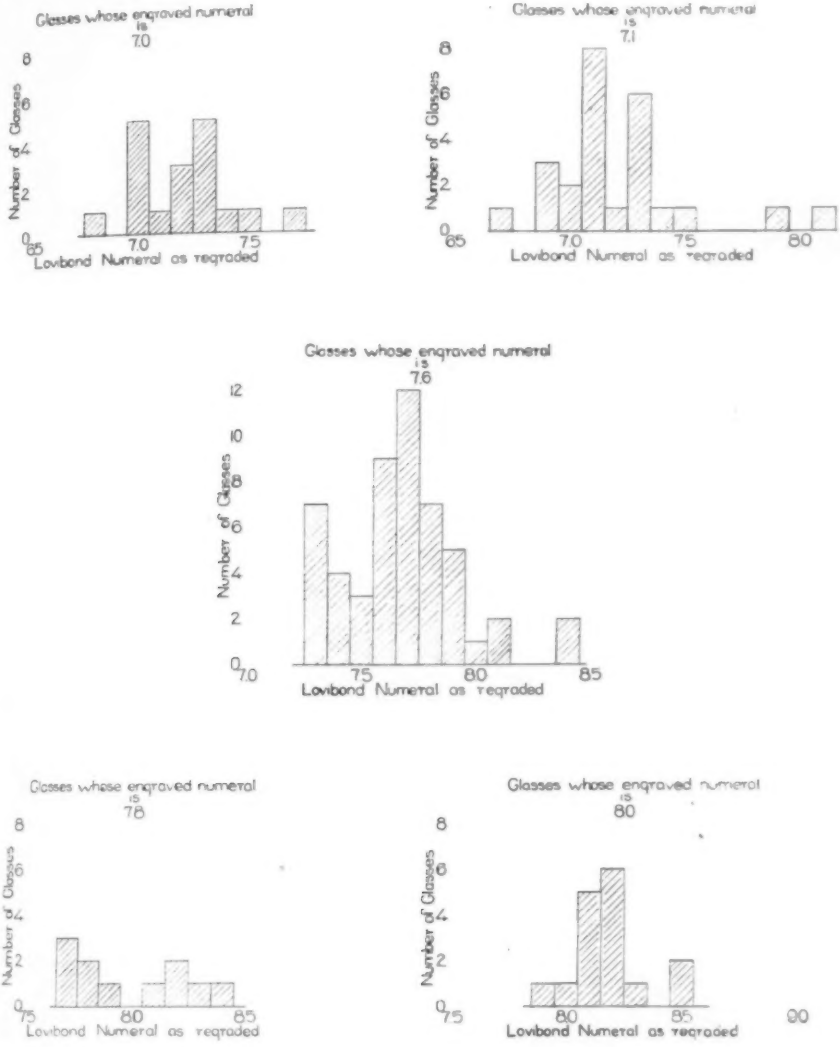

Glasses whose engraved numeral is 7.0
Number of Glasses
Lovibond Numeral as regraded
Glasses whose engraved numeral is 7.1
Number of Glasses
Lovibond Numeral as regraded
Glasses whose engraved numeral is 7.6
Number of Glasses
Lovibond Numeral as regraded
Glasses whose engraved numeral is 7.8
Number of Glasses
Lovibond Numeral as regraded
Glasses whose engraved numeral is 8.0
Number of Glasses
Lovibond Numeral as regraded

Fig. 1

The distribution of glasses of constant engraved numeral according to their regrade numerals

tween 7.5 and 7.7, 15 had been engraved 7.6. If the 129 glasses may be considered a fair sample, it may appear that a glass has little chance of being between 7.5 and 7.7 unless its engraved numeral is 7.6. Such a conclusion is not justified, however, because so few glasses of engraved numeral close to 7.6 were submitted (4 marked 7.4, none marked 7.5, none marked 7.7, and 11 marked 7.8). Indeed Table 4

does justify an expectation quite the contrary, since, of the 52 glasses engraved 7.6, only 29 per cent (15 out of the 52) were found to be between 7.5 and 7.7.

It is immediately apparent from Fig. 1 that the present regrading corroborates previous findings of inaccuracies in the engraved numerals of Lovibond red glasses between 7.0 and 8.0 if those engraved numerals are to be considered an index of color. As typical of these inaccuracies may be taken the occurrence of the regrade numerals for the glasses engraved 7.6. It is seen that these regrade numerals cover a range of 1.1 Lovibond red units. If these 52 glasses constitute a fair sample, the degree of inaccuracy to be expected in the maker's grading of Lovibond red glasses between 7.0 and 8.0 is such that two glasses having the same engraved numeral might really differ by an amount corresponding to more than 1.0 Lovibond red unit.

It may also be noted from Fig 1, without difficulty at least for glasses engraved 7.0, that the mean of the regrade numeral does not agree with the engraved numeral. In Table 5 the means of the regrade numerals (third column) are compared with the engraved numerals (second column).

It is found that the engraved numerals are consistently smaller than the mean of the regrade numerals, the differences (fourth column) ranging between 0.08 and 0.20 with an average (weighted according to the number of glasses) of 0.12. It seems safe to conclude, therefore, that, *if these* 122 *glasses can be considered a fair sample*, the scale established by Priest and Gibson departs by about 0.1 from the average Lovibond red glass between 7.0 and 8.0 in use in the United States; it is equally clear, however, that the deviation (0.12 Lovibond red units) of the scale established by Priest and Gibson is negligible in comparison with the variations which may apparently occur within a group of glasses of the same engraved numeral (See Fig. 1). To make possible a direct comparison, the average and maximum deviations from the mean regrade numeral have been computed for each group of constant engraved numeral (columns 5 and 6, Table 5). The average deviation from the mean ranges from 0.11 to 0.23 Lovibond red units with a

TABLE 5

Deviation of Grades as Submitted From the Priest-Gibson Scale Compared to Variations Among Glasses of the Same Engraved Number

Number of Glasses	Lovibond Numeral Engraved on Glass	Mean of Regrade Lovibond Numerals	Engraved Numeral Minus Mean of Regrade Lovibond Numerals	Average Deviation From Mean of Regrade Lovibond Numerals	Maximum Deviation From Mean of Regrade Lovibond Numerals
18.....	7.0	7.20	—0.20	0.17	0.50
25.....	7.1	7.20	—0.10	0.21	0.90
52.....	7.6	7.68	—0.08	0.19	0.72
11.....	7.8	7.98	—0.18	0.23	0.42
16.....	8.0	8.18	—0.18	0.11	0.32
122	Weighted Means:		—0.12	0.18	

grand average of 0.18 which is actually larger than the deviation (0.12) of the engraved numerals from the mean. The maximum deviation from the mean ranges from 0.32 to 0.90 Lovibond red units, compared to which the deviation of the engraved numerals from the mean is, of course, unimportant. The scale established by Priest and Gibson from the glasses of the Bureau set known as "B.S.9940" seems, then, to be, for red glasses between 7.0 and 8.0, a satisfactory evaluation of the average Lovibond glass in use in the United States for the grading of vegetable oils. Though not a matter of primary importance, it is perhaps fortunate that the limited number of glasses on which this scale was based happened to be a fair representation of glasses in use in this country rather than consistently high or low by 0.6 or 0.7 units as is shown in this report to be perfectly possible (See column 6, Table 5).

In investigating possible causes for these occasional large irregularities it was noted that a few of the glasses (26 out of 129, See Table 6) could easily be separated from the mass because of their abnormal shape, some being abnormally thick as if to guard against breakage (column 6) others being unfinished at the edges (column 4) as if they had been cut from a larger piece of glass without subsequent smoothing of the edges. The character of these abnormalities in shape suggests that perhaps these glasses did not originate from the Lovibond establishment but had been prepared elsewhere to serve as working standards. If this were true it would probably be safe to assume that the grading, being a grading of working standards only, would be less reliable than that performed at the Lovibond establishment. The suspicion that these glasses might not have come from the Lovibond establishment is further strengthened when it is noted that a number of these same glasses do not bear the engraved word "Lovibond." To test whether there exists a significant connection between the engraved marks and abnormalities in shape, the glasses were divided into three

TABLE 6

Connection Between the Engraved Marks and the Abnormalities in the Shape of the Glasses

Group	Criterion for Grouping	Total Number of Glasses	Number of Glasses of Abnormal Shape: Rough-Edged No.	%	Thicker Than 3 mm. No.	%	Total Number of Glasses of Abnormal Shape No.	%
1	Those having "Lovibond" engraved on them	92	3	3	5	6	8	11
2	Those have "Reg'd No. 410631" engraved on them	13	0	0	0	0	0	0
3	Those which do not belong to either of the first two groups	24	13	54	7	29	18	75
	Totals	129	16		12		26	

groups according to their engraved marks: (1) those bearing the engraved mark "Lovibond," (2) those bearing the engraved mark "Reg'd No. 410631" but not "Lovibond," and (3) those bearing neither of these marks.

Table 6 shows that there *is* a connection between the engraved marks and the abnormalities in shape; 75 per cent (18 out of 24) of the glasses in group 3 are of abnormal shape, and 69 per cent (18 out of 26) of the glasses of abnormal shape are also glasses of group 3. It is concluded, therefore, that the glasses in group 3 are probably different in origin from those of groups 1 and 2. Perhaps they are working standards rather than authentic Lovibond glasses. If this is the case, it is possible that the engraved numerals of the glasses of group 3 are less reliable as an index of their color than those of the glasses of groups 1 and 2. Table 7 serves to investigate this possibility by evaluating the average deviation of the regrade numerals from the engraved numerals.

It is shown in table 7 that the mean deviations of the regrade numerals from the engraved numerals are, in three cases out of five, greater for group 3 than for groups 1 and 2, being particularly greater for glasses having engraved numerals 7.1 among which glasses many (11 out of 21) of the glasses of group 3 occur. It is safe to conclude that the glasses of group 3, tentatively regarded as working standards, are somewhat less accurately graded by their engraved numerals than are glasses of groups 1 and 2. The average mean deviation for group 3 is 0.258 as compared to 0.192 for groups 1 and 2.

TABLE 7

Relative Reliability of the Engraved Numerals of Group 3 and the Engraved Numerals of Groups 1 and 2

Lovibond Numeral Engraved on Glass	Number of Glasses (n)			Average Deviation From Lovibond Numerals (D)		
	All Glasses	Groups 1 and 2	Group 3	All Glasses	Groups 1 and 2	Group 3
7.0	18	15	3	0.22	0.23	0.20
7.1	25	14	11	0.20	0.14	0.27
7.6	52	48	4	0.20	0.19	0.25
7.8	11	9	2	0.24	0.21	0.35
8.0	16	15	1	0.19	0.20	0.15
Totals.....	122	101	21	Mean	0.205	0.192	0.258

Group 3, then, is made up of glasses which are less copiously engraved, less carefully finished and less carefully graded. It is consistent to regard group 3 as made up of working standards rather than primary standards. The primary standards themselves (groups 1 and 2), however, are not strikingly superior to the working standards since they are characterized by an average deviation only about 30 per cent smaller (compare 0.192 with 0.258). The separation of group 3 has served to account, then, for only a minor portion of the errors discovered in the engraved numerals as indices of color. The numerals engraved on Lovibond red glasses between 7.0 and 8.0 must, therefore, be regarded as only an approximate index of their color.

The American Oil Chemists' Society

Notes and Correspondence

Standardization of Lovibond Glasses

Report for November, 1927

1. Determination of the spectral transmission of the following red glasses from B. S. 9940 has been completed and the data adopted (Gibson and Walker): 0.11, 0.17, 0.18, 0.19, 0.26.

2. Report on "A Study of 129 Lovibond Red Glasses with Respect to the Reliability of their Nominal Grades," being prepared by Judd and Walker for publication in "Oil and Fat Industries" (Official Organ of the A.O.C.S.) has been edited and revised and is nearly ready for publication.

3. Report by Priest on "Tests of Color Sense and Power of Color Discrimination of Members of the A.O.C.S.: Data on Sensibility to Change in Lovibond Red at 35 Yellow 7.6 Red" has been edited and revised and is nearly ready for publication.

4. Miss Walker has carried through extensive tests of Priest's proposed new method of using the Arons chromoscope for routine grading of the red glasses with 35 yellow. Considerable time has been given to eliminating conditions conducive to error and to improving the technic of this method. The first results were not satisfactory, but the sources of the trouble were rather easily detected. At the close of the month Miss Walker's most careful work indicates that accurate and reliable results can be obtained by this method: and it seems highly probable that this method will be quite valuable in grading the glasses. Further tests of this method are being made. The data so obtained also serve as a most valuable check on the values previously assigned to the standard glasses by Priest and Gibson.

5. Gibson (with Riley's assistance) has undertaken the calibration of the red glasses in B. S. 9940 by computation from spectral transmission data obtained by Frehafer in 1920. This calibration is identical in form to the first step (N') in the calibration made by Priest and Gibson on the basis of data by Gibson and Harris; but is based on independent experimental data on spectral transmission. Preliminary results of this computation were about ready at the end of the month; but since they must be reviewed and checked before being accepted, comment upon them is reserved until next month.

6. Gibson (with Riley's assistance) has undertaken on the basis of spectral transmission; a calibration of red glasses, B. S. 9940 in combination with 35 yellow B. S. 10289B. This calibration is identical in form with the first step (N') in the previous calibration by Priest and Gibson. It involves, however, the transmission of a different yellow glass. Its principal interest and importance is that it affords an independent check upon the *accuracy* of *the computation* and graphic reduction leading to the first adjustment (N') in the calibration by Priest and Gibson (April, 1927).

7. Priest has made some preliminary experiments on determining directly, with the Martens photometer and suitable filters, a ratio

of transmissions, which might serve as an interpolation parameter instead of the r/g ratio (computed from spectral transmission) used by Priest and Gibson in calibrating the red glasses. These experiments have not yet led to definite conclusions. It seems likely, however, that this idea can be developed.

IRWIN G. PRIEST
Chief, Colorimetry Section.

Memorandum of Conference, December 10, 1927

1. Mr. H. P. Trevithick and Mr. A. W. Putland representing the A.O.C.S. visited the Bureau Saturday morning, December 10th and conferred with those who have been working on the standardization at the Bureau: Priest, Gibson, Judd, Walker.

2. Copies of the report on the work for November were given to Messrs. Trevithick and Putland and several of the items in the report were explained orally.

3. The new method proposed by Priest for grading red glasses by means of the Arons chromoscope was demonstrated.

4. The question of testing the color discrimination of members of the A.O.C.S. was discussed at some length. Mr. Priest agreed to test those who might come to the Bureau for that purpose. It was also tentatively decided to make such tests at the next convention of the Society; but no definite plans for such tests were decided upon.

5. Mr. Trevithick returned the MS of paper by Judd and Walker (A Study of 129 Lovibond Red Glasses with Respect to the Reliability of Their Nominal Grades) approved for publication.

6. It was decided to dispose of the tests of the 35-yellow glasses now at the Bureau before starting routine grading of red glasses to be submitted.

7. It was decided to begin routine grading of red glasses as soon as the tests on these 35-yellow glasses are disposed of (probably about January 15th).

8. It was decided that work on the red scale should be undertaken first for Lovibond numerals 5 to 8 to be followed by lower numerals.

9. It was decided that a satisfactory degree of accuracy in calibration of the red glasses between 5 and 8 would be reached if each numeral determined experimentally could be certified to be within 0.1 unit of the true value.

10. It was decided that the calibration for each red glass should consist of:

(1) Determination of the correct numeral based on the standards established by Priest and Gibson, May, 1927.

(2) Determination of the departure from normal sunlight transmission of the test glass combined with 35-yellow specifically,

$$\frac{T_a - T_n}{T_n}$$

where:

T_a is actual sunlight transmission of a combination consisting of the glass being tested and a 35-yellow glass, and:

T_n is the sunlight transmission proper to a combination consisting of the same 35-yellow and a normal red glass having the numeral assigned to the glass being tested.

11. A set of rules concerning labelling, shipping and reporting upon red glasses to be submitted was adopted. Copy of these rules is attached hereto.

12. A form for reporting upon the calibration of red glasses was approved. Copy of this form has been furnished Mr. Put'and.

Bureau of Standards and American Oil Chemists' Society Investigation of Uniformity of Lovibond Glasses in Use in the United States

Rules for Labeling, Submitting, Shipping and Reporting upon Red Glasses to be Submitted by the A. O. C. S.

(Adopted December 10, 1927)

1. Glasses will be submitted in lots of 25 glasses, each lot to consist of glasses all of the same Lovibond numeral.

2. No combinations are to be submitted.

3. Each glass shall be marked by an identification number, preceded by the mark: AOCS, in as nearly as possible uniform style on all of the glasses. This legend shall be engraved on the glass on the same side as the Lovibond engraved marks but at the opposite end. The series of numbers will begin with 200 so that the first glass will be marked as follows:

AOCS
200

4. The responsibility for marking the glasses and keeping the record of their ownership will be assumed by Mr. A. W. Putland who will send the glasses to the Bureau after they are marked.

5. Glasses will be shipped by express prepaid to the Bureau, addressed

Bureau of Standards
(Attn. Miss Geraldine K. Walker)
Div. IV, Sec. 3,
Room 407 South Building,
Washington, D. C.

6. As an employee of the AOCS, Miss Walker will be responsible for receipt of the glasses, their calibration, and their return after testing.

7. Calibrated glasses will be packed by Miss Walker and returned by express collect via B. S. Shipping Department to Mr. A. W. Putland, Portsmouth Cotton Oil Refining Corp., Portsmouth, Va.

8. Report on calibration as per standard form shall be prepared by Miss Walker and transmitted to Mr. Putland by the Chief of the Colorimetry Section through the Director of the Bureau.

9. A photostat copy of each report shall be retained at the Bureau.

Tank Car Sampling

To All Members:

The Rules of the Interstate Cottonseed Crushers' Association prescribes that in sampling tank cars, a trier be used which will take a two-inch sample the full depth of the oil in the car, and that this sample must be of uniform diameter throughout its depth.

There are a number of samplers on the market, but it is questionable whether any of them fulfil the requirements of the rules. For this reason, at the suggestion of Mr. V. Serbell, the President has appointed a special committee, under the Chairmanship of Mr. W. G. McLeod, whose address is c/o Armour and Co., Chicago, Illinois, to investigate the samplers at present in use and, if any is found which meets the specifications of the Rules, to suggest to the meeting in May that this sampler be designated as Official.

Further, if no such sampler be found, the committee will devise one which will be in accord with the Rules. This committee is now investigating all the samplers in use and seeks the co-operation of all members of the Society in this work.

Very truly yours,

H. P. TREVITHICK, *President.*

OIL & FAT INDUSTRIES
Sir:

In the November, 1927, issue of OIL & FAT INDUSTRIES, there is an article by Miss Rosalind U. Norris on The Standardization of Oil for Mayonnaise, containing "Standards and Specifications for a Refined, Deodorized Mayonnaise Oil," Article 5 of which "Standards and Specifications" is practically a winter test which specifies a temperature of 32°F. for cottonseed oil, 22°-27°F. for corn oil, and 21°-25°F. for sesame oil.

I would greatly appreciate information through the columns of OIL & FAT INDUSTRIES or otherwise, as to the effect a winter test has on the making of mayonnaise, and incidentally why the temperatures specified for corn oil and sesame oil are so much lower than that given for cottonseed oil.

This is the only point in the specifications not clear, and I heartily agree with all the other articles.

Very truly yours,

G. A. MOORE.

The Editor
OIL & FAT INDUSTRIES
Sir:

The reason that corn and sesame oils may be substituted for cottonseed oil in the production of mayonnaise during the winter months, is that the naturally lower "freezing" points of these oils lowers the freezing point of the finished product.

Our experience in the past has proved to us the necessity of specifying these "freezing points," as some refined oils have occasionally shown the presence of a flocculent precipitate at these temperatures.

Very truly yours,

ROSALIND U. NORRIS.

Book Reviews

STANDARDS YEARBOOK 1927 FIRST ISSUE. Prepared by the National Bureau of Standards of The Department of Commerce. Pp. 398 6 by 9 inches, 39 illustrations. Washington, Government Printing Office.

The Standard Yearbook represents an effort to present an adequate picture of the diversification and ramification of the standardization movement which has spread throughout the world with astonishing vitality during the 25 years that has elapsed since the establishment of the National Bureau of Standards. It contains outlines of the activities and accomplishments of not only this bureau and other agencies of the Federal Government and the States and municipalities, but also of the American societies and associations of which standardization is a major or very important activity. Descriptions and illustrations are presented of all the fundamental national standards of the United States. Moreover, outlines are given of the various foreign national and the several international standardizing agencies.

In a general review of the standardization movement in America attention is directed to the remarkable growth in the activities of the trade associations, the development of "mass-production," method of factory production, and to the vital

interest now being shown in standardization by industrial executives. Noteworthy in the trend of the development of standards is the process based on the elimination of excess varieties and sizes which is supplementary to the slower process involving technical consideration. A development of no little importance is the substitution of performance, or service, requirements for composition specifications in certain lines of manufacture.

To manufacturers, industrial experts, engineers, and purchasing agents, both governmental and general; to all officers and agencies concerned with standardization, the Standards Yearbook will be most valuable. It will inform the manufacturer of the current standardization movements affecting his industry. It will inform purchasing agents of new standard specifications and will inform the scientist engaged in research as to current research projects which may lead to standardization. To the average reader it will prove a mine of information on the present status and trend of standardization in all fields of industry, commerce, science, and Government, with references to sources of further information.

This valuable publication may be obtained by sending $1.00 cash or money order to the Superintendent of Documents, Government Printing Office, Washington, D. C.

CHEMISTRY OF THE OIL INDUSTRIES. By J. E. SOUTHCOMBE. 2nd Edition Revised and Enlarged. Pp. 224. New York: D. Van Nostrand Co.

Like many other books of this character, it is more or less of a compilation, and appears to contain a comparatively small amount of original material.

The following criticism from "The Analyst" of May, 1927, seems to be well merited:

The scope of the book, which deals with both the mineral oil and the fatty oil industries, remains the same as in the previous edition; the general arrangement of the subject matter and a large proportion of the text have not been altered. Whilst most of the chapters in the new edition contain but little new matter, that dealing with mineral oils has been largely rewritten. A chapter dealing with the "Theory of the Colloidal State" (an addition suggested in the previous review in this journal) has been added, together with a somewhat incomplete bibliography.

The new edition contains many statements and opinions which, while sound in 1913, have now become out of date and have not been removed or replaced. Many of the developments of the last thirteen years either are not mentioned or are dealt with, inadquately. Thus, the author has devoted to the catalytic hydrogenation of oils two short passages occupying about ten lines in all, and, of these, one is misleading. He makes no mention of the chemistry of the process or of the very extensive use of hydrogenated oils in lard substitutes and margarine, although sections on the composition of such substitutes are included.

The chapter on "Analytical Methods" has been reprinted, word for word, from the first edition; as was remarked in the review of that edition, "the methods savour more of the lecture room than of the technical laboratory"; the value of this chapter would have been greatly enhanced by revision. Of the methods included, one, described as the Reichert-Meissl process for the determination of soluble volatile fatty acids, is actually the Reichert-

Wollny process; and a second, attributed by the author to Holde, for the detection of mineral oils in vegetable oils, is a test based by the author on the surprising and erroneous statement that "mineral oils are insoluble in 96 per cent alcohol, but all fats dissolve fairly readily." Holde's test, which is not described, is based on the principle that when vegetable oils are boiled with alcoholic potash, an alcohol-soluble soap is formed, whereas mineral oils remain unchanged and insoluble under the same treatment.

The book contains an example of the manner in which misleading statements are copied from one book to another. A table on p. 77 has been abstracted from a similar table in Ubbelohde. The figures for the proportions of fat in copra and in palm fruit are reversed in Ubbelohde and remain reversed in both editions of Southcombe.

DAVID WESSON.

THE ANALYSIS OF PIGMENTS, PAINTS AND VARNISHES. By J. J. FOX and T. H. BOWLES. Pp. 179. New York: D. Van Nostrand Co.

This book is well written and is a fairly complete compendium of the analysis of the principal dry pigments used in the manufacture of paints.

The chapter on The Analysis of Mixed Paints is not quite as complete as it might be, although for England where dry colors and paste oil colors are more largely sold, the book is of undoubted value.

In America where millions of gallons of flat wall paints are used every year, there are many types which contain appreciable quantities of water, most of them contain flatting materials of the stearate type, and others are made from cold cut Pale East India Gums. It is essential to know how to analyze these materials, although perhaps not as essential in Europe as it is in America. It is regrettable that the book is incomplete.

All in all, this is quite a useful book, particularly for beginners.

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